Ice Covered Ocean Response to Atmospheric Storms (ICORTAS)

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LONG-TERM GOALS

The ICORTAS project proposes to investigate the spin-up and spin down of the upper ocean in response to storms. Fluctuating surface stresses excite inertial oscillations in the ocean mixed layer. It is believed that in the absence of ice-cover, very little inertial energy is dissipated in the upper ocean, since observations of downward propagation energy fluxes are comparable to the near-inertial input of wind-energy in the mixed layer (Leaman and Sanford 1975; D'Asaro et al. 1995). Instead, most of the energy propagates as internal waves in the stratified ocean below the mixed layer. These waves arise from an ``inertial pumping'' mechanism (Gill 1984), although D'Asaro (1995) stresses the importance of viscous coupling at the base of the mixed layer. These oscillations are in the form of near-inertial internal gravity waves, which can propagate meridionally in the frequency range between the buoyancy frequency (several cycles per hour) and the local inertial frequency (ranging from one cycle every 16 hours at mid-latitudes to one cycle every twelve hours at the poles). The evidence for significant energy input through an ice-cover is contradictory, and this project aims to clarify this issue.

OBJECTIVES

- ICORTAS proposes to investigate the spin-up and spin down of the upper ocean in response to storms. The observational system measures surface-to-bottom currents and density structure, offering a unique opportunity to expand our understanding of how the ocean couples surface mesoscale variability and wave excitation to the underlying oceanic response.

WORK COMPLETED

ICORTAS joined with another ONR-sponsored program "Circulation, cross-shelf exchange, sea ice, and marine mammal habitats on the Alaskan Beaufort Sea Shelf," denoted BSA-NOPP, which investigates how Arctic shelves will respond to a changing ice-cover. The focus is on cross-shelf exchange using moorings, at-sea surveys, and remote sensing to quantify ice evolution and wind-forced cross-shelf exchange during storm events. Satellite remote sensing uses the RGPS system of Kwok (2001) to measure sea-ice deformation at 100m resolution over the study area with three day temporal resolution. The partnership between ICORTAS and BSA-NOPP is very natural. Cross-slope

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exchange measurements can now be extended from the inner shelf (10m) to the far outer shelf (2000m). The remote-sensing component will be enriched by expanded ground-truthing, with ADCP measurements of sea-ice deformation at high temporal resolution. ICORTAS will be able broaden the resolved spatial scales, and will utilize the very high spatial resolution of the RGPS remote-sensing products.

In August 2008, the PI deployed the three-mooring array in the Beaufort Sea (moorings I1-I3 in Fig. 1). The expanded field program (ABS-NOPP + ICORTAS) consists of a total of ten moorings measuring physical parameters. An ICORTAS 300khz ADCP with bottom tracking was placed on moorings T1, and a 75khz ADCP was placed on B4. Mooring B3 was jointly constructed by BSA-NOPP and ICORTAS, with a McClane MMP profiler that measures both current and density. Each ICORTAS mooring is equipped with thermistor strings to resolve thermal structure to within 20m of the surface, an upward looking ADCP at 80 m depth, an MMP, and several CTDs at depth (Fig. 1). The vertical resolution and rapid sampling allow for a complete modal description of the wave field. The triangular mooring layout allows for estimates of both across and along shelf energy flux. Moorings T1, T2, and B4 have full-depth velocity coverage. The array is positioned in a seasonal ice zone, so that both ice-covered and ice-free conditions will be sampled, allowing for first order effects of sea ice on the internal wave field to be diagnosed. All ten moorings were recovered in late July 2009.

RESULTS

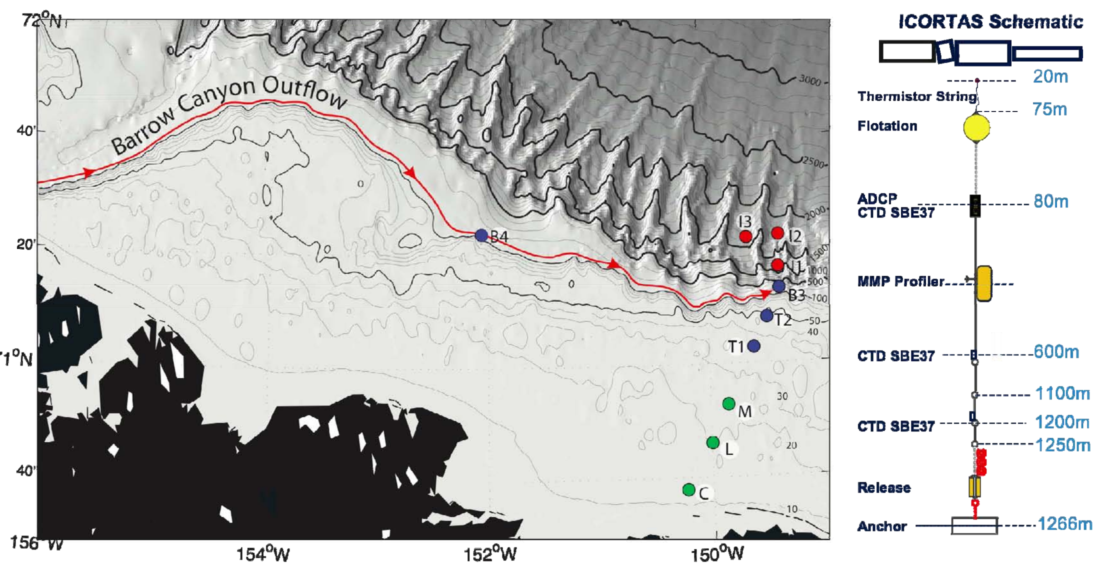

Figure 1. : Left panel: Location of ICORTAS moorings (I1-I3) and of BSA-NOPP moorings (C, L, M, T1, T2, B3, B4). Depth contours are indicated along the right-hand side. Right panel: Example ICORTAS deep water mooring diagram (I1). ICORTAS instrumentation were also included on moorings T1 and B4. The ten-mooring array offers an unprecedented opportunity to track ice-motion, monitor shelf-basin exchange (the focus of the Pickart/Weingartner study), and the shoaling of high-frequency waves that are the focus of this project. The combined mooring array covers scales from 10 to 100km and extends from 10 to 1800m water depth. Note that the shelf-break and canyon slopes are critical to almost all incoming waves.

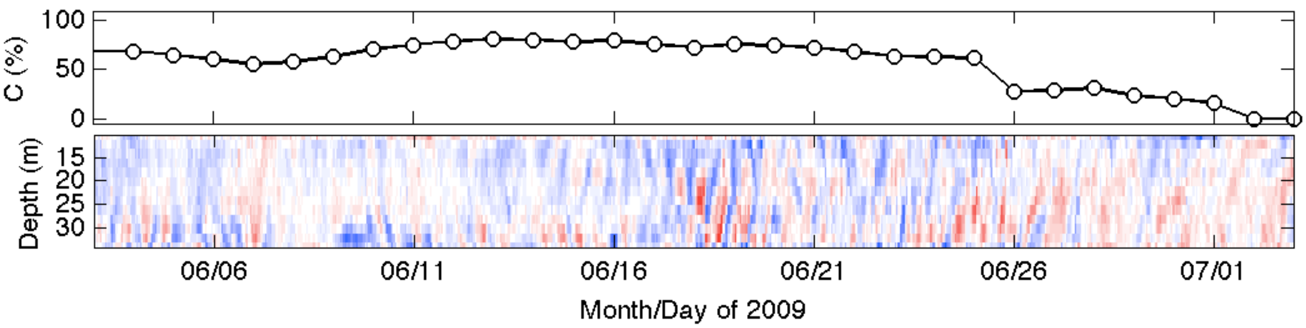

Figure 2. : Top panel: Daily sea-ice concentration from SSM1 passive microwave satellite. Bottom panel: hourly shear measured from the ADCP on mooring B3. After June 16th, as the ice cover weakens, there is upward phase propagation, evidence of downward energy transport into the ocean interior.

IMPACT/APPLICATIONS

TRANSITIONS

RELATED PROJECTS

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PUBLICATIONS

No articles have been published this year on this project.